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CHAPTER 11

PROACTIVE OR RISK MANAGEMENT CASES

11.1 DROUGHT IN THE U.S. GREAT PLAINS ⁽¹⁾

by

NORMAN J. ROSENBERG and DON A. WILHITE

There is good evidence that droughts have been a recurrent feature of the climate of the Great Plains for as far back, at least, as man has inhabited the region. Much of the evidence is based on chronologies of tree rings. Specimens of red cedar and western yellow pine found in western Nebraska were studied by Weakly (1965). In the time span extending back to 1220 A.D., he found many short periods of drought. Droughts frequently lasted for more than five years, and one such period lasted 38 years. Will (1946) found a similar pattern in central North Dakota extending back to 1539 A.D. More recently, Stockton, Mitchell and Meko (1981) have prepared time series of drought indices based on tree rings since 1700 A.D. for several Great Plains sites.

In American consciousness the Great Plains is the region most often associated with drought in the U.S. Early explorers crossing the Great Plains from the humid east were struck by the dryness of the region. Bark (1978) cites the example of Zebulon Pike who crossed the southern plains in 1810 and described the mid-continent in these emphatic words... 'in time it may become as celebrated as the sandy desert of Africa.' Stephen Long in 1822 also described what we now call the Great Plains in such terms as... 'almost wholly unfit for cultivation and, of course, uninhabitable by a people depending on agriculture for subsistence.' In view of the fact that, today, the Great Plains is a major 'bread basket' of the nation, some have suggested that Pike and Long probably passed through the region during periods of drought and, hence, their views were unfavorable. Goetzmann (1966) believes that Pike and Long may have been quite reasonable in their views. With the technology then available, settlement of the plains region would indeed have been extremely difficult.

Lawson (1975) studied how the concept of the Great American desert fared at a later time when he reconstructed the

(1) Paper prepared specially for this volume.

weather of April to July 1849 from diaries of 49'ers crossing the Plains on the Oregon trail to the gold fields of California. The spring began very wet, and cold and wagon trains were delayed at their starting points waiting for the grass to sustain their animals. By mid-July dust storms were noted as far east as North Platte '...as the argonaut continued west, the roads that had been heavy because of rain now became clogged with sand.' While the 49'ers 'waded to California in the first months of their journey across the plain - the appearance of the desert was not spared them.'

By the 1880's, extensive settlement had taken place in the Great Plains, particularly in Kansas and Nebraska. The fear of drought was somewhat allayed by a series of good years. Science was invoked to explain the good growing conditions. Professor Samuel Aughey of the University of Nebraska developed a theory that came to be known as 'rain follows the plow.' Bark (1978) quotes Aughey as follows:

'It is the great increase in absorptive power of the soil, wrought by cultivation, that has caused and continues to cause an increasing rainfall in the state. After the soil is broken, a rain as it falls is absorbed by the soil like a huge sponge. The soil gives this absorbed moisture slowly back to the atmosphere by evaporation. Thus year by year as cultivation of the soil is extended, more of the rain that falls is absorbed and retained to be given off by evaporation, or to produce springs. This, of course, must give increasing moisture and rainfall.'

In the late 1880s and early 1890s drought revisited the Great Plains region. Between 1888-92 fully half the settlers of Kansas and Nebraska left the region (Warrick and Bowden 1981). The drought became yet more severe between 1893-95. Figures on outmigration during this period demonstrate how poorly adapted agricultural development was to the natural environment. Although these events laid Aughey's theory to rest, it is interesting to note that today there is widespread speculation that irrigation is moderating the climate and increasing precipitation in the Great Plains region.

Serious but short-lived droughts occurred throughout the mid-continent in the years 1910, 1911 and 1913. It was not until the 1930s that the most severe and widespread drought of historic times occurred--from the west coast to the Ohio valley and from Mexico to Canada. In the 1950s a major drought occurred in the central United States. It was most severe in the southern plains and southwestern states.

The most recent drought of regional scale occurred during 1976 and 1977. Most of the U.S. from Illinois and Michigan west to California and Washington were affected. The impacts and lessons of these twentieth century droughts are discussed in detail below.

11.1.1 Measuring drought severity

How can we compare the severity of droughts that occur in different places and at different times? How can we know when a drought is in progress, where aid is most needed or when it has ended? Any number of mathematical and statistical formulae have been proposed for classifying drought severity on the basis of shortages of precipitation. Agricultural drought begins when rainfall is insufficient for crop growth, but when the soil contains sufficient moisture to support the crops the impact is delayed until after much of the soil water is depleted.

Drought severity is closely associated with the intensity and duration of the moisture shortage. Intensity and duration are generally measured by the departure of a certain climatic index (or indices) from normal. The most commonly used indices of drought severity in the U.S. are percent of normal precipitation and the Palmer Drought Severity Index (PDSI). The PDSI (Palmer 1965) attempts to express the soil moisture situation in terms of past weather conditions. The PDSI is used to describe periods of abnormally wet or dry weather. PDSI values range from approximately +6.0 to -6.0. A value less than -4.0 indicates extreme drought. In rare instances the PDSI will be less than -6.0, as it was for portions of the Pacific Northwest and upper midwest during 1977.

The PDSI has proven very useful as a means of describing the changing extent of drought and its severity. An example is shown for southwestern Kansas in Figure 11.1-1. The range of PDSI from 1900 to 1976 indicates, as is typical for subhumid and semiarid regions, a frequent oscillation between conditions too wet and too dry. The index illustrates the unusually severity and duration of drought in the 1930s and 1950s in southwestern Kansas.

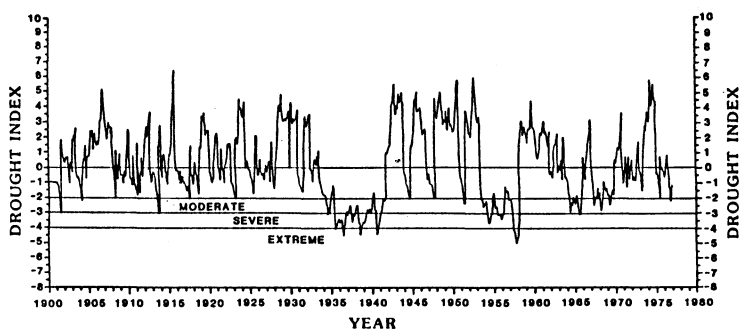


Figure 11.1-1. Index of drought in southwestern Kansas.

Droughts also differ in their spatial characteristics, a feature which may affect governmental response or the

implementation of drought management strategies (Wilhite 1983). Long-term drought mitigation programs have been developed for those portions of the country where drought is a frequent and recurring problem.

11.1.2 Lessons of the twentieth century droughts

The 1930s. 1934 was one of the worst years of the 1930s drought. The PDSI has been calculated for three periods during that year (Fig. 11.1-2). In spring (Fig. 11.1-2a), after two previously dry years in the upper midwest, the southwest and mountain states were already experiencing severe moisture shortages. By July 1 (Fig. 11.1-2b) virtually all of the United States and parts of Mexico and Canada, as well, were in severe drought. Drought was most severe in Illinois and Wisconsin and also in portions of the intermountain west. The drought was alleviated in much of the midwest by October 1, 1934 (Fig. 11.1-2c), but had intensified greatly in the upper Great Plains and intermountain west.

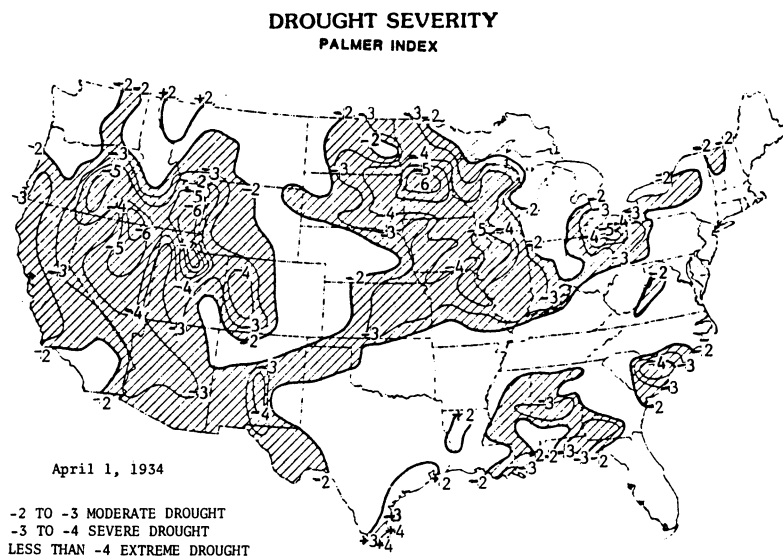


Figure 11.1-2a. Drought severity in April 1934.

The drought of the 1930s coincided with the most severe economic depression of this century - a depression worldwide in extent. After a number of consecutive drought years many

DROUGHT SEVERITY **PALMER INDEX**

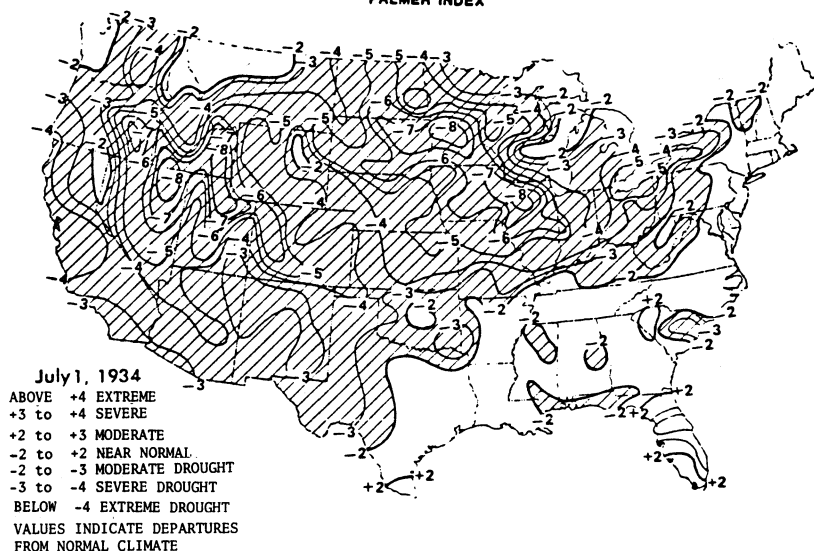


Figure 11.1-2b. Drought severity in July 1934

DROUGHT SEVERITY **PALMER INDEX**

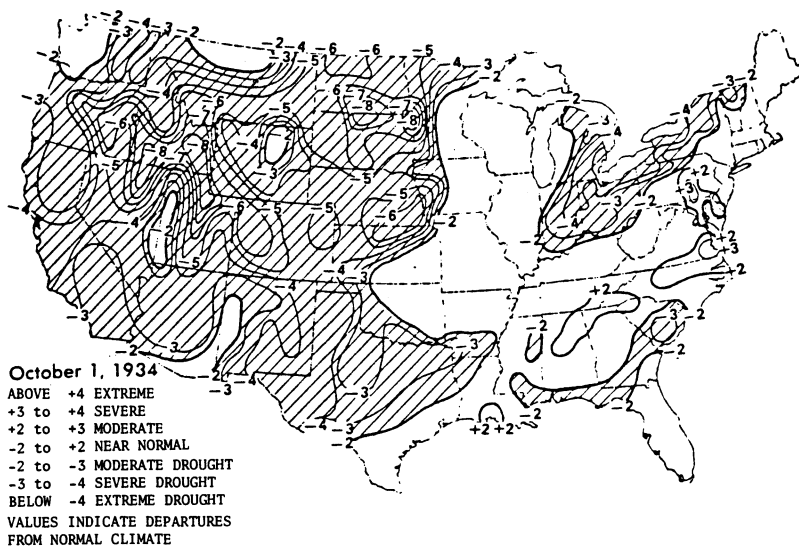


Figure 11.1-2c. Drought severity in October 1934.

farmers were forced to sell out and abandon their land. The images of outmigration from the Great Plains were captured in the dramatic photographs of Arthur Rothstein and others in the paintings of Alexandre Hogue, in the songs of Woodie Guthrie, and in such novels as Steinbeck's Grapes of Wrath.

Serious dust storms due to accelerated wind erosion began in the early 1930s. Some have attributed these storms to overuse of the land, particularly at the western edge of the plains where annual rainfall is normally only 12-14 inches. Land better suited to grazing had been broken by the plow and intensively cultivated for wheat production. Between 1909 and 1929, over 32 million acres of sod were broken by Great Plains farmers. In the heart of the Dust Bowl, wheat acreage increased by as much as 1,000 percent between 1925 and 1931 (Hurt 1982).

Governmental involvement in drought relief in the United States prior to the 1930s was negligible. For example, farmers and others in regions affected by drought in the 1890s were forced to rely on charitable funds from local and outside sources, but government (local, state and federal) participated very little.

During the early stages of the 1930s drought, the Hoover administration responded by urging greater self-help and local participation in relief efforts. The Red Cross amended its charter so that it might accept responsibility for the administration of drought relief (Woodruff 1977). Previously drought had not been considered an 'Act of God'--the only type of disaster with which the Red Cross was chartered to deal.

A county-by-county survey of the drought affected areas was made by the U.S. Department of Agriculture (Aistrup 1956) and a National Drought Relief Committee was established in 1930 (USDA 1930). The committee included representatives of the railway and banking industries. As the drought continued to intensify President Hoover gave his support to legislative action to provide farmers with crop production loans. Primarily, however, the Hoover administration approached drought relief by encouraging voluntary programs.

The first years of the Roosevelt administration coincided with a deepening drought problem. Emergency, short-term and long-term measures were planned and implemented. Emergency livestock and feed programs, seed purchase programs and human relief programs were put into effect (U.S. House of Representatives 1934). The government began to acquire submarginal land not suited to crop production. Soil conservation activities were intensified; a Shelterbelt Project (officially, the Prairie States Forestry Project) was initiated. The intent of this program was to plant tree windbreaks in regular patterns throughout the Great Plains in order to retard wind erosion. It was thought possible by some that the climate of the region might be moderated, as well. By the time the project ended in

1942, the Forest Service had planted nearly 18,600 miles of shelterbelts with 217 million trees (Hurt 1982). The 1930s saw an increase in water resource development projects-- especially the construction of dams to impound water for hydroelectric generation and for irrigation.

For the first time a system was developed for determining which areas needed drought assistance. Assessments were based on recommendations of the Bureau of Agricultural Economics and the Federal-State Cooperative Extension Service of the U.S. Department of Agriculture (Murphy 1935). These assessments relied on field reports of crop and pasture conditions, departure from normal precipitation, percent change in cattle numbers and on reports of human distress. The process of designation began with appeals for federal relief from the Governors of the affected states or from state drought committees.

Much was learned from the drought of the 1930s. The need for proper management of the soil and water resources of the country, especially in the sensitive and vulnerable Great Plains region, was a primary lesson. One report from that era stands out--The Future of the Great Plains, published in 1937 by a Presidentially appointed Great Plains Committee. The Committee recommended actions to develop... 'a type of economy that will withstand the shocks of recurrent periods of severe and prolonged drought.' The Federal government was urged to conduct necessary investigations and surveys, to acquire land in range areas and to control the use of such lands, to introduce measures to increase the size of farms so as to make them more viable economically, to develop water resources, to resettle persons displaced by the drought, to provide compensation to local governments on account of federal land acquisition, to control destructive insect pests and to develop alternative generators of income for the region such as lignite.

The states were urged to undertake necessary surveys and revisions of state law, to zone land for its best use, to promote the organization of grazing associations, to develop soil conservation districts, to impose taxes on delinquent range lands, to facilitate change in community organization and fiscal arrangements, to further the development of water resources and to deal with the problems of land occupancy and land tenure.

The legislation prompted by the 1930s drought and the organization and institutions fostered altered, apparently unchangeably, the role of government in drought relief. The actual physical and economic tactics introduced in the 1930s may have had the effect of lessening the impact of later droughts.

The 1950s. In the late 1940s and early 1950s, drought developed in the southwestern and southern plains states.

Drought intensified and spread throughout the southern and central Great Plains, reaching its maximum extent in the mid-1950s. The severity of the drought is shown by maps of the Palmer Index for April 1, July 1 and October 1, 1956 (Figs. 11.1-3a,3b,3c). In April much of the northwest, southwest and midwest were experiencing moderate to severe drought. A band from southern New England into the Ohio Valley was affected as was the entire state of Florida. By July the drought had broken in the western states; in fact, water was in excess. The drought had become considerably more severe in the southwest and in much of the plains region. Drought persisted in Florida. The growing season of 1956 passed with little relief in the southwest, mountain and plains states as is shown in the map for October 1. The area affected by drought was smaller in 1956 than in 1934. In the southwest, however, the drought was more severe than it had been in the 1930s. Actually, in west Texas, 10 consecutive years of drought were experienced. In Nebraska only 1955 and 1956 were notably dry.

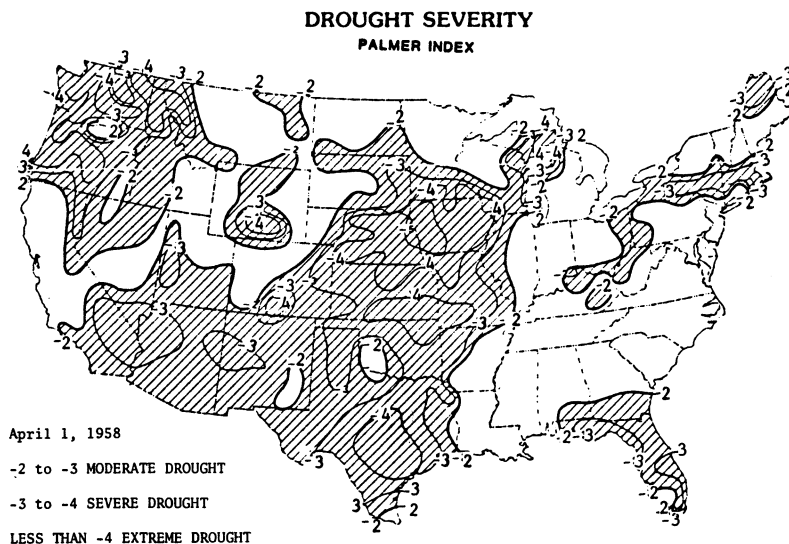


Figure 11.1-3a. Drought severity in April 1956.

In general, the impacts of the drought of the 1950s were less than in the 1930s. Warrick and Bowden (1981) have compared drought impacts by reference to a number of indicators

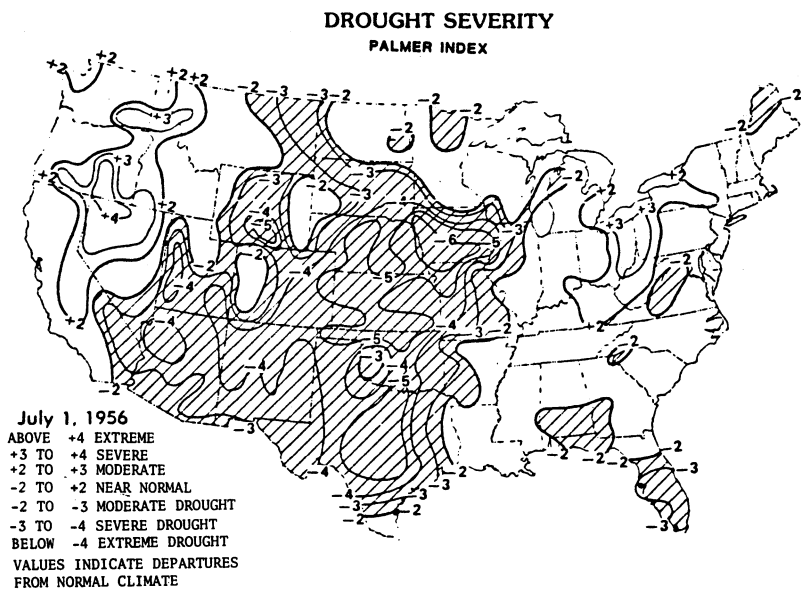


Figure 11.1-3b. Drought severity in July 1956.

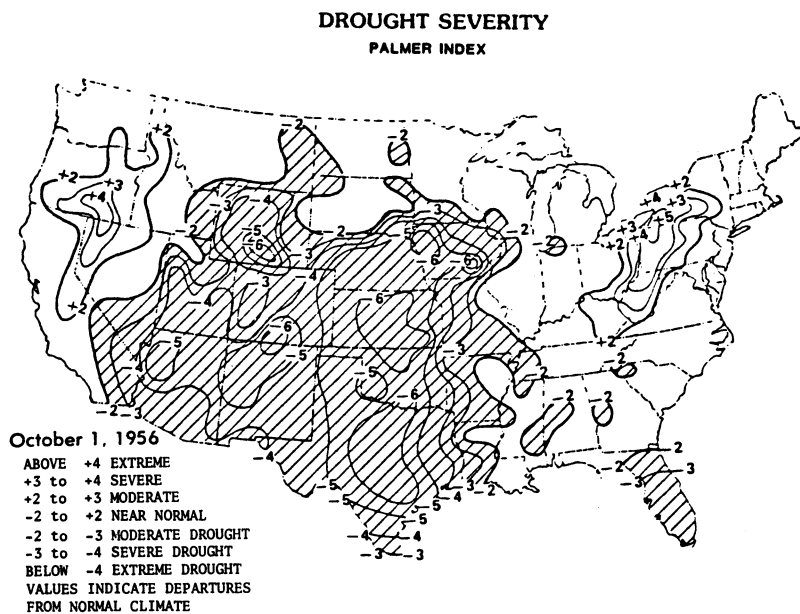


Figure 11.1-3c. Drought severity in October 1956.

of stress--wheat yields, population declines, farm transfers and relief payments. Wheat yields were compared for each major drought with those in the preceeding and succeeding good years. The average decline was 35% in the 1930s; in the 1950s drought, it was only 10%. However, when duration and extent of the drought are considered by dividing the yield reduction by the months that all reporting divisions experienced drought, the percent reductions are nearly identical.

In previous droughts, especially before the 1930s, shortages of food had led to famines and illness on the Great Plains. During the 1930s droughts, the Roosevelt administration, particularly, provided unprecedented amounts of government aid to combat economic depression as well as drought. In the 1950s, health impacts were not significant (Warrick and Bowden 1981).

Records indicate that nearly three hundred thousand people left the plains during the drought period of the 1890s, although that drought was far less severe than that of the 1930s. In the 1910s, population displacement was also not small when scattered incidents of drought in the western Dakotas and southern plains caused losses of as much as 25-50% of the population. An extensive outflux of settlers occurred in eastern Montana, as well (Warrick and Bowden 1981).

Despite the severity and duration of the 1930s droughts, the blowing dust and the poor crop yields, relative population declines were actually less than in earlier droughts. Warrick and Bowden (1981) found that the outmigration was more uniform across the plains region--about 6% for the entire region but 18% for Oklahoma. This uniformity may have been as much the result of economic depression as of drought. In the 1950s depopulation was not significant. Records show no difference from the wetter decades of the 1940s and 1960s.

Other evidence of declining impact of drought is drawn from the records of farm transfers. At the peak of the 1930s drought-plus-depression, one farm in ten changed hands. Fully half of the transfers were involuntary and came about as the result of forced sales and related defaults. Involuntary transfers were almost insignificant from 1945 on through the droughts of the 1950s and 1970s, as well.

By the onset of the 1950s drought, the concept of public relief had become totally acceptable as a social mechanism for alleviating drought stress. Total federal assistance, however, was less in the 1950s drought than in the 1930s (400-700 million dollars vs. 1 billion dollars or more). An Emergency Feed Program was initiated first. By October, 1954, 869 counties in 15 states were designated as eligible for drought relief (USDA 1954). A Hay Program subsidized the transport of emergency feeds. A Feed Grain Project distributed surplus feed grains. Measures were taken to control wind erosion, to construct stock ponds and lakes (U.S. Executive Office of the

President 1959). Government credit was expanded to include funds for additional on-farm soil and water conservation measures. Industrial development was promoted by the Department of Commerce to help diversify the economy of the drought affected region. Long-range water resource planning was undertaken on the basis of various scenarios of population growth and movement within the plains region.

A major outcome of the 1950s drought was the creation in 1956 of the Great Plains Conservation Program administered by the Soil Conservation Service. The major aim of the Program was to encourage a form of land use that recognized both the region's capabilities and its limitations.

In March of 1957, President Eisenhower submitted a report to the 85th Congress entitled 'Report on Drought and Other Natural Disasters.' In his letter of transmittal the President commented '...it is an obligation of all levels of government, and of all of our people, to plan whatever steps may be helpful in preventing or mitigating the effects of future disasters' (President of the United States 1957).

The role of government in preventing and/or mitigating the effects of drought seemed fully established. However, the report itself raises '...a serious question whether producers should continue to be eligible for government aid and support if they persist in following programs that have been determined to be unsound for the area.'

Drought in the 1970s. The drought of the 1970s is freshest in mind, of course. Its extent and severity when it appeared worst in the central Great Plains is shown in the Palmer Drought Severity Index map for April 1977 (Fig. 11.1-4). Drought had first appeared in the southwest in 1974. By August of that year half the western states were affected.

In the midwest the drought had begun with a hot and windy growing season in 1976. In Nebraska, for example, rates of water use by irrigated crops were 30-40% greater than normal (Rosenberg and Verma 1978). Yields of unirrigated corn during 1976 were severely reduced because of extreme heat and dryness during the critical reproductive stage when the silks appear and pollen is released. The winter of 1976-77 was unusually dry and warm so that by spring a wheat crop disaster was fully expected. The drought in the midwest was actually most severe in Wisconsin and Minnesota although the eastern Great Plains was also seriously affected.

The situation was dramatized when, in late February, dust storms began to occur in the western Plains. Two such storms can be seen in the GOES satellite picture of North America taken on February 29, 1977 (Kessler et al. 1978). Separate storms originated in eastern Colorado and the Panhandle region of Texas. The origin of the moving dust in the Texas storm coincides closely with an abrupt change in agricultural

DROUGHT SEVERITY PALMER INDEX

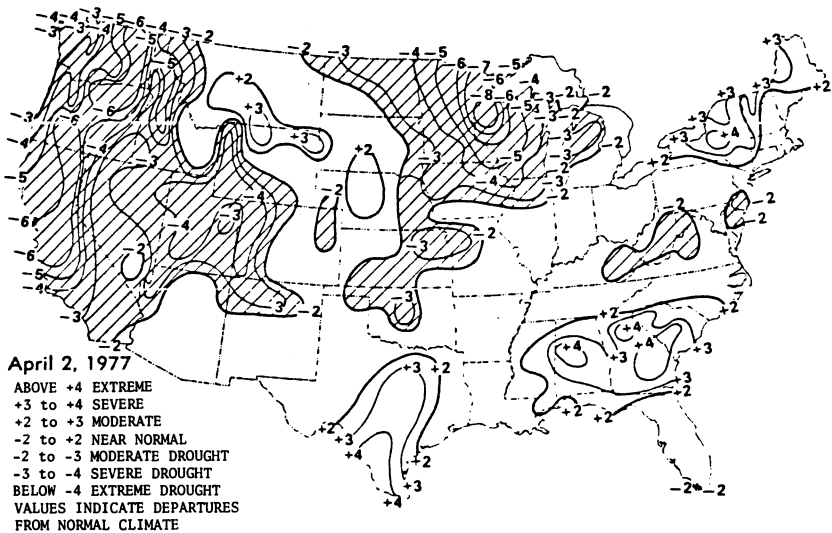


Figure 11.1-4. Drought severity in April 1977.

practice. Rangeland predominates on the New Mexico side of the border and cropland on the Texas side. All totaled, wind erosion damaged almost six million acres in Colorado, Texas, Kansas, Oklahoma and New Mexico during 1977 (Hurt 1982). Thus, the great dust storms that characterized the drought years of the 1930s are still a feature of the Great Plains during drought.

By mid-August, 1977 the drought was broken in the southern and central Great Plains states. Moisture was, in fact, excessive in central Nebraska. The drought continued unabated, however, in parts of the southeast, in the upper midwest and northern plains and in the mountain and far western states. In the far west two winter seasons with little rainfall had already passed. Since winter is the 'rainy season' on the west coast, that region had no prospect for relief for some months to come. Serious shortages of water for municipalities and industries were occurring, generation of hydroelectric power was being reduced and water supplies for irrigation agriculture were growing short.

What were the impacts of the drought of the 1970s? Wheat yields, one criterion used by Warrick and Bowden (1981), declined only 10% from those in prior and later good years, but the decline per division-month of drought was not different--18%--from that in the 1930s and 1950s drought periods. Since, in the central Great Plains, the drought ended abruptly in spring, the wheat which had survived the dry

planting and dormancy periods was actually well supplied with water during the flowering and maturing stages. Thus the overall impact of the drought on wheat production was moderated.

The drought of the 1970s in the Great Plains was, mercifully, of short duration: no starvation or significant outmigration is known to have occurred. Because of the earlier onset of drought in the western states, governmental agencies were already engaged in modest mitigation efforts by the late winter and spring of 1977 when, from the national viewpoint, the drought became most severe.

A great number and diversity of governmental programs were put into effect by the Carter Administration in early 1977 (Wilhite 1983). Drought was the first critical domestic issue faced by the administration. Pressure from the governors of the 17 western states led to an early meeting with the new Secretary of the Interior, Cecil Andrus, and to the appointment of a federal drought coordinator, Jack Watson.

By March 23, President Carter had submitted a request to Congress for 844 million dollars for loans and grants to farmers, ranchers, communities and businesses affected by drought (WESTPO 1978). Elements of the program included low cost emergency loans to cover prospective losses to farmers and ranchers, low cost loans and grants to communities of less than 10,000 people for emergency water supplies, cost-sharing grants for soil conservation practices, increases in the capital of the Federal Crop Insurance Corporation, creation of a waterbank, grants to states for protection of fish and wildlife, low cost loans for water supply and conservation measures, emergency loans to irrigators, purchase of energy power supplies, low interest loans for small businessmen including farmers.

By late April, an interagency committee involving the Departments of Agriculture, Commerce, Interior and the Small Business Administration had been formed with authority to designate areas eligible for federal assistance as a result of drought (Wilhite 1983). The Committee reviewed gubernatorial requests for designation of all or a portion of the state as Emergency Drought Impact Areas. Approval made the affected areas eligible for federal assistance under the President's program. By mid-September almost 2200 counties, over two-thirds of those in the U.S., had received committee designation. However, the President's program was only a small portion of the total federal drought assistance program during 1976-1977. In total, 16 federal agencies administered 40 separate programs with expenditures in excess of 5 billion dollars (General Accounting Office 1979).

This exposition of federal and state responses to drought in the 1970s is incomplete. It is intended to show, merely, how government involvement in the mitigation of drought

impacts has grown in scope and complexity since the 1930s. Ex post facto documentations of these relief activities have been conducted by agencies of government. An evaluation of the success and efficiency of the mid-1970s drought response is currently underway at the University of Nebraska. (2)

11.1.3 Conclusions

Drought is a normal part of the climate of the Great Plains and its recurrence is inevitable. Previous droughts have resulted in the implementation of a wide range of emergency, short-term and long-term measures to alleviate some of its hardships. While these measures have reduced the severity of drought impacts and facilitated the adoption of improved soil and water conservation techniques, the 1976-77 drought episode was a stark reminder of our continuing sensitivity to this feature of climate. The recurrence of drought, the intensity and duration of that which ravaged the Great Plains during the 1930s and 1950s would, undoubtedly, lead to serious impacts on the natural environment as well as on the social and economic well-being of the region.

Although each drought differs in its impact, there is much that we can learn by studying societal response to earlier droughts. It is important to evaluate drought assistance programs and designation procedures to determine which were successful and which were not. The lessons learned can guide government in the development of plans for improved response to forthcoming droughts. However, now is the time to prepare.

(2) Government response to the mid-1970s drought: A case-study of three Great Plains states. D. A. Wilhite, N. J. Rosenberg and M. H. Glantz. NSF Grant No. ATM-81-08447.